PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-246562

(43)Date of publication of application : 26.09.1995

(51)Int.Cl. B24D 3/06
B24D 3/00
B24D 3/00
B24D 3/10

(21)Application number : 06-065752

(22)Date of filing : 09.03.1994

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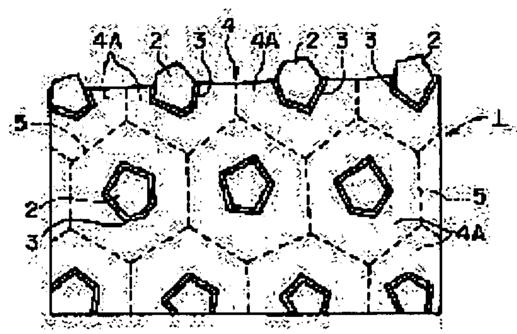
(54) METAL BONDED GRINDING WHEEL AND ITS MANUFACTURE

(57)Abstract:

PURPOSE: To provide a metal bonded grinding wheel and its manufacturing method which can prevent a seizure of a work to be ground to a grinding surface.

CONSTITUTION: A metal bonded abrasive grain layer 1 which is formed by scattering super abrasive grains 2 in a metal bonded phase 4 is provided. The metal bonded phase 4 is formed of a sintered alloy including 20 to 95wt.% of Cu, 5 to 50wt.% of Sn, and 0.5 to 3wt.% of oxygen. The super abrasive grains 2 are provided dispersing three-dimensionally placing about even intervals in the metal bonded phase 4, the metal bonded phase 4 has spherical shell form parts 4A surrounding the outer peripheries of individual super abrasive grains in a spherical shell form, and the spherical shell form parts 4A are connected at the mutual border surfaces 5 so as to compose the metal bonded phase 4.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

PAT-NO: JP407246562A

DOCUMENT-IDENTIFIER: JP 07246562 A

TITLE: METAL BONDED GRINDING WHEEL AND ITS MANUFACTURE

PUBN-DATE: September 26, 1995

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APPL-NO: JP06065752

APPL-DATE: March 9, 1994

INT-CL (IPC): B24D003/06, B24D003/00 , B24D003/00 , B24D003/10

ABSTRACT:

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CONSTITUTION: A metal bonded abrasive grain layer 1 which is formed by scattering super abrasive grains 2 in a metal bonded phase 4 is provided. The metal bonded phase 4 is formed of a sintered **alloy including 20 to 95wt.% of Cu, 5 to 50wt.% of Sn, and 0.5 to 3wt.% of oxygen**. The super abrasive grains 2 are provided dispersing three-dimensionally placing about even intervals in the metal bonded phase 4, the metal bonded phase 4 has spherical shell form parts 4A surrounding the outer peripheries of individual super abrasive grains in a spherical shell form, and the spherical shell form parts 4A are connected at the mutual border surfaces 5 so as to compose the metal bonded phase 4.

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CLAIMS

[Claim(s)]
[Claim 1] It is the metal bonded grinding wheel characterized by being formed with the sintered alloy with which it is the metal bonded grinding wheel equipped with the metal-bond abrasive grain layer which comes to distribute superabrasive into the metallic-bond phase, and said metallic-bond phase contains a 20 - 95wt% Cu, a 5 - 50wt% Sn, and 0.5 - 3wt% oxygen.
[Claim 2] Said metallic-bond phase is a metal bonded grinding wheel according to claim 1 characterized by containing one sort or two sorts or more of metals further chosen from Fe, nickel, Co, W, Ti, and Ag.

[Claim 3] It is the metal bonded grinding wheel according to claim 1 or 2 characterized by said metallic-bond phase consisting of the contact surfaces where the spherical shell-like part into which said metallic-bond phase surrounds the periphery of each superabrasive in the shape of a spherical shell, respectively, and which has the spherical shell-like part of the diameter of fixed mostly, and adjoins and suits is mutual continuously while said superabrasive vacates mutual almost equal spacing and is distributed in three dimension in said metallic-bond phase.
[Claim 4] The metal bonded grinding wheel according to claim 3 characterized by forming independent pore in the boundary between said spherical shell-like partial, and making the porosity of said metal-bond abrasive grain layer into 5 - 30vol% by this.
[Claim 5] The average outer diameter of said spherical shell-like part is a metal bonded grinding wheel according to claim 3 or 4 characterized by being carried out by 1.2 to 4 times the mean diameter of said superabrasive.
[Claim 6] The plating process which forms a metal plating layer by the nonelectrolytic plating method on the surface of superabrasive, and produces a plating abrasive grain, Each mixes said plating abrasive grain with the mixed powder which uses Cu powder with small mean particle diameter, and Sn powder as the main raw material from these plating abrasive grain. By adding pressurization rolling movement to the bottom of oxygen existence, and making the mixed powder of each of said metal stick by pressure on said metal plating layer according to a mechanical friction welding operation The sticking-by-pressure covering process of forming a sticking-by-pressure enveloping layer in the periphery of said plating abrasive grain, producing a metallic-coating abrasive grain, and moreover making said mixed powder containing oxygen in the process, Said sticking-by-pressure enveloping layer is combined for said metallic-coating abrasive grain compacting and sintering, or by carrying out a hotpress. The manufacture approach of the metal bonded grinding wheel which considers as the sintered alloy containing a 20 - 95wt% Cu, a 5 - 50wt% Sn, and 0.5 - 3wt% oxygen, and is characterized by providing the forming cycle which forms a metal-bond abrasive grain layer by this.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the metal bonded grinding wheel which can prevent printing and fixing of the **-ed material to a grinding side, and its manufacture approach.
[0002]
[Description of the Prior Art] these after a general metal bonded grinding wheel mixes superabrasives, such as a diamond or CBN, to homogeneity and molds this mixed powder into metal powder, such as Cu or Sn, with base metal -- press forming -- and it is sintered and manufactured. In addition, generally the oxygen content in the sintered metal used as a joint phase is made good [little direction] from a viewpoint which raises a degree of sintering.
[0003]
[Problem(s) to be Solved by the Invention] However, in the conventional metal bonded grinding wheel, when grinding of the **-ed material, such as a comparatively soft metal and glass, was carried out, it burned or was easy to fix **-ed material in the shape of a layer to the grinding side of a grinding stone, and sharpness fell for a short time, grinding force resulted in increase and grinding impossible, and there was a fault that a life was short.
[0004] It is making into the technical problem for this invention to offer the metal bonded grinding wheel which was made in view of the above-mentioned situation, and can prevent printing and fixing of the **-ed material to a grinding side, and its manufacture approach.
[0005]
[Means for Solving the Problem] In order to solve said technical problem, the metal bonded grinding wheel concerning this invention is a metal bonded grinding wheel equipped with the metal-bond abrasive grain layer which comes to distribute superabrasive into the metallic-bond phase, and said metallic-bond phase is characterized by being formed with the sintered alloy containing a 20 - 95wt% Cu, a 5 - 50wt% Sn, and 0.5 - 3wt% oxygen.
[0006] In addition, a metallic-bond phase may contain one sort or two sorts or more of metals further chosen from Fe, nickel, Co, W, Ti, and Ag. Moreover, while superabrasive vacates mutual almost equal spacing and is distributed in three dimension in said metallic-bond phase, said metallic-bond phase may consist of the contact surfaces where the spherical shell-like part into which said metallic-bond phase surrounds the periphery of each superabrasive in the shape of a spherical shell, respectively, and which has the spherical shell-like part of the diameter of fixed mostly, and adjoins and suits is mutual continuously.
[0007] On the other hand, the manufacture approach of the metal bonded grinding wheel concerning this invention The plating process which forms a metal plating layer by the nonelectrolytic plating method on the surface of superabrasive, and produces a plating abrasive grain, Each mixes said plating abrasive grain with the mixed powder which uses Cu powder with small mean particle diameter, and Sn powder as the main raw material from these plating abrasive grain. By adding pressurization rolling movement to the bottom of oxygen existence, and making the mixed powder of each of said metal stick by pressure

on said metal plating layer according to a mechanical friction welding operation The sticking-by-pressure covering process of forming a sticking-by-pressure enveloping layer in the periphery of said plating abrasive grain, producing a metallic-coating abrasive grain, and moreover making said mixed powder containing oxygen in the process, Said sticking-by-pressure enveloping layer is combined for said metallic-coating abrasive grain compacting and sintering, or by carrying out a hotpress. It considers as the sintered alloy containing a 20 - 95wt% Cu, a 5 - 50wt% Sn, and 0.5 - 3wt% oxygen, and is characterized by providing the forming cycle which forms a metal-bond abrasive grain layer by this.
[0008]
[Function] Since the metallic-bond phase is formed with the sintered alloy containing Cu which is 20 - 95wt%, Sn which is 5 - 50wt%, and the oxygen which is 0.5 - 3wt% according to the metal bonded grinding wheel concerning this invention, the wettability and reactivity over **-ed material of a metallic-bond phase are low. It is rare to burn **-ed material into grinding by this in a grinding stone grinding side.
[0009] Moreover, since said mixed powder is made to contain oxygen in a sticking-by-pressure covering process according to the manufacture approach of the metal bonded grinding wheel concerning this invention, making the mixed powder of each metal stick by pressure on a plating abrasive grain according to a mechanical friction welding operation, a sticking-by-pressure enveloping layer with an oxygen content almost uniform to the interior can be formed. Since the whole region is covered and an oxygen content can form an almost uniform metallic-bond phase by fabricating and sintering the metallic-coating abrasive grain which has such a sticking-by-pressure enveloping layer, also when wearing the metallic-bond phase out gradually by grinding, the wettability and reactivity of a metallic-bond phase over **-ed material are always kept low, and printing stabilized [long duration] and the fixing prevention effectiveness are acquired.
[0010]
[Example] Next, the example of the metal bonded grinding wheel concerning this invention and its manufacture approach is explained to a detail. Drawing 1 is the cross-section enlarged drawing showing the metal-bond abrasive grain layer 1 of the metal bonded grinding wheel of the 1st example. Since this invention has the description in the structure of this metal-bond abrasive grain layer 1, the grinding stone may be constituted by only the abrasive grain layer 1, and the abrasive grain layer 1 may be fixed to the suitable grinding stone base. In this invention, the configuration of a grinding stone is not limited, either but it can apply to the grinding stone of any formats currently used conventionally and a configuration.
[0011] The metal-bond abrasive grain layer 1 vacates mutual almost equal spacing into the metallic-bond phase 4, and comes to distribute the superabrasives 2, such as a diamond or CBN, in three dimension, and it has spherical shell-like partial 4A of the diameter of fixed mostly, and when [whose metallic-bond phase 4 surrounds the periphery of each superabrasive 2 in the shape of a spherical shell, respectively] these spherical shell-like partial 4A continues in the mutual contact surface, the metallic-bond phase 4 is constituted. Moreover, spherical shell-like partial 4A is constituted by the thin metal plating layer 3 directly formed in the periphery of superabrasive 2, and the sintering alloy layer prepared in the periphery. However, it does not have the boundary where the metal plating layer 3 and the sintered alloy layer of the periphery are clear, and the boundary may be not clear by being spread mutually and suiting it in fact. The same is said of the interface 5 of spherical shell-like partial 4A.
[0012] the metallic-bond phase 4 -- Cu -- 20 - 95wt% -- more -- desirable -- 35 - 70wt% and Sn -- 5 - 50wt% -- more -- desirable -- 10 - 30wt% and oxygen -- 0.5 - 3wt% -- more -- desirable -- 1 - 2wt% -- it contains, respectively. one sort or two sorts or more of metals chosen from Fe, nickel, Co, W, Ti, and Ag in addition to these elements -- desirable -- less than [50wt%] -- if you may contain, in addition a small amount of unescapable impurity and the need are accepted, the alloying element or the filler may be included. In addition, since the rate of occupying in the metallic-bond phase 4 of the metal plating layer 3 is small, the presentation of the metallic-bond phase 4 may be considered to be the presentation of a sintered alloy layer.
[0013] The metal plating layer 3 was formed in order to raise the junction nature of a sintered metal layer and superabrasive 2, and it is formed in the peripheral face of superabrasive 2 by the

nonelectrolytic plating method (depending on the case, electrolysis plating may be performed further). As the quality of the material of the metal plating layer 3, Cu is chosen for Cu, nickel, Co, Ag, etc. especially suitably, and the thickness is set to about 2-20 micrometers from the reasons of manufacture.
[0014] When the problem which runs short of degrees of sintering will be produced if there are few Sn contents in the metallic-bond phase 4 than 5wt(s)%, and 50wt% is exceeded, the metallic-bond phase 4 carries out embrittlement, and it becomes impossible to use it as a grinding stone. If the problem which carries out embrittlement and cannot fabricate a grinding stone will be produced on the other hand if there are few contents of Cu in the metallic-bond phase 4 than 20wt(s)%, and 95wt% is exceeded, the problem that sintering becomes difficult will be produced.
[0015] Although an oxygen atom's in metallic-bond phase 4 existence gestalt is not clear, it is thought that it exists as an oxygen dissolution metal phase or metallic oxides, such as Cu and Sn, and distribution of an oxygen atom continues throughout a sintered alloy layer, and is desirable. [of an almost uniform thing] The prevention effectiveness of printing or fixing is not acquired as the oxygen content in the metallic-bond phase 4 is less than [0.5wt%], if [than 3wt%] more, the reinforcement of the metallic-bond phase 4 will be insufficient, and sufficient abrasive grain holding power will not be acquired.
[0016] the average outer diameter of spherical shell-like partial 4A, i.e., alienation of superabrasive 2, -- it considers as 1.5 to 2 times more preferably, and, thereby, the thing of a pitch of the mean particle diameter of superabrasive 2 for which the degree of concentration of superabrasive 2 is set about to 50 to 250 is 1.2 to 4 times more desirable. the degree of concentration of superabrasive 2 is less than 50 -- a cutting edge -- a consistency is insufficient, sharpness falls, the abrasive grain holding power by the metallic-bond phase 4 is insufficient for an adult grinding stone, and it is more difficult to manufacture than 250.
[0017] Since the metallic-bond phase 4 is formed with the sintered alloy containing a 20 - 95wt% Cu, a 5 - 50wt% Sn, and 0.5 - 3wt% oxygen according to the metal bonded grinding wheel which consists of the above-mentioned configuration, the wettability and reactivity of the metallic-bond phase 4 over **-ed material are low. It can prevent by this that **-ed material is burned into grinding in a grinding stone grinding side, and it is possible to prevent the early fall of sharpness and extension of a grinding stone life can be aimed at. And since it continues throughout the metallic-bond phase 4 and the above-mentioned presentation is maintained, it is burned even if it wears the metallic-bond phase 4 out gradually, and a prevention operation does not change, but the effectiveness continued and stabilized at the long period of time is acquired.
[0018] Moreover, since spacing of each superabrasive 2 is prescribed by the thickness of spherical shell-like partial 4A, as compared with the conventional grinding stone, distribution of the superabrasive 2 in a grinding side is uniform, and can also reduce dispersion in grinding precision a top with little dispersion in sharpness.
[0019] In addition, although the metal-bond abrasive grain layer 1 was non-pore mostly in the example of drawing 1 instead, as shown in drawing 2 , the independent pore 6 may be formed along the interface 5 of spherical shell-like partial 4A. The conditions at the time of fabricating the metal-bond abrasive grain layer 1 can adjust such magnitude and abundance of the independent pore 6 to some extent. When forming the independent pore 6 in the metal-bond abrasive grain layer 1, as for the porosity, it is desirable that it is 5 - 30vol%. Without falling most reinforcement of the metallic-bond phase 4, if it is this range, the chip eccritic from a grinding side and the cooling nature of the grinding stone by grinding fluid can be raised, and it is possible to improve sharpness further as a result.
[0020] Next, the example of the manufacture approach of the above-mentioned metal bonded grinding wheel is explained using drawing 3 and drawing 4 . By this approach, the superabrasive 2 as shown in drawing 3 (a) is prepared first, the metal plating layer 3 is formed in that peripheral face by the nonelectrolytic plating method, and the plating abrasive grain 10 as shown in drawing 3 (b) is produced. The suitable thickness of the metal plating layer 3 is about 2-20 micrometers from the reasons of manufacture, as stated previously. In less than 2 micrometers, formation of the sticking-by-pressure enveloping layer 11 becomes difficult, and if thicker than 20 micrometers, it will be because futility

arises in cost.
[0021] Although forming only by the nonelectrolytic plating method is also possible, every time the metal plating layer 3 accepts the need, it may perform electrolysis plating further after nonelectrolytic plating, and may make the metal plating layer 3 heavy-gage. In addition, in order for the plating abrasive grain 10 under pressurization stirring mentioned later to roll, and for the configuration of superabrasive 2 to improve a sex and to make easy homogeneity formation of the sticking-by-pressure enveloping layer 11, the spherically nearer one is desirable, but unless it has the shape of an extreme scale, even if it uses the abrasive grain of an indeterminate form, the sticking-by-pressure enveloping layer 11 can be formed enough.
[0022] Next, the thick sticking-by-pressure enveloping layer 11 is formed in the periphery of the plating abrasive grain 10, and the metallic-coating abrasive grain 12 as shown in drawing 3 (c) is produced (sticking-by-pressure covering process). The plating abrasive grain 10 and one sort or two sorts or more of metal powder with which mean particle diameter is chosen as small Cu powder, Sn powder, and a list from Fe, nickel, Co, W, Ti, and Ag by each if needed from these plating abrasive grain 10 are specifically mixed, pressurization rolling movement is added to this mixture under oxygen existence, and metal powder is made to stick by pressure on the metal plating layer 3 according to a mechanical friction welding operation. Some amounts of dissolution oxygen of metal powder are increased to coincidence in the process, or/and some metal powder is oxidized to it, and it is made to generate an oxygen dissolution metal phase or/and a metallic oxide in the sticking-by-pressure enveloping layer 11. Although it is good in air as an oxygen existence ambient atmosphere, other oxidizing gases may be moderately diluted and used with inert gas.
[0023] Drawing 4 shows an example of the pressurization rolling equipment used at the above-mentioned sticking-by-pressure covering process. The sign 20 in drawing is the cylinder-like drum installed by leveling an axis, and rotates by the driver focusing on an axis. The fixed shaft 21 is arranged along with an axis, the pressurization arm 22 is fixed downward to this shaft 21, the pressure plate 23 which makes the shape of radii parallel to the inside of a drum 20 is fixed to that lower limit by the interior of a drum 20, and the fixed gap is formed in it between this pressure plate 23 and drum 20 inside. Moreover, from the pressurization arm 22, the scraping arm 24 prolonged in a slanting lower part is fixed to the method side of method Kogo of drum rotation, and the lower limit is formed in the shape of the edge of a blade, and achieves the operation which fails to scratch the fine particles adhering to drum 20 inside.
[0024] In order to perform sticking-by-pressure covering, a drum 20 is sealed by putting the plating abrasive grain 10 and said metal powder into a drum 20 at a predetermined rate, and plugging up the opening with a lid (illustration abbreviation). In addition, as for the mean particle diameter of the metal powder to be used, it is desirable that it is 0.1-50 micrometers. In less than 0.1 micrometers, condensation of metal powder becomes easy to take place to sticking-by-pressure covering and coincidence, and formation of a sticking-by-pressure enveloping layer becomes difficult. On the contrary, in size, the plating abrasive grain 10 cannot become a core easily, and sticking-by-pressure condensation of metal powder happens and is not more desirable than 50 micrometers.
[0025] Although the mixing ratio of the plating abrasive grain 10 and metal powder which are invested in a drum 20 is determined according to the thickness of the sticking-by-pressure enveloping layer 3 which should be formed, for forming a sticking-by-pressure enveloping layer efficiently, about amount =of amount:metal powder of plating abrasive grains10:1-1:5 is desirable at a volume ratio. What is necessary is to add metal powder on the way and just to continue sticking-by-pressure covering in one pressure-welding covering, when covering thickness is insufficient.
[0026] If a drum 20 is rotated where mixed powder is fed into a drum 20, mixed fine particles are pressurized in the clearance between a pressure plate 23 and a drum 20, by a collision and friction of particles, local generation of heat and impulse force, and the ductility force will arise in the interface of each particle, and metal powder will fix in the shape of a dumpling on the front face of the plating abrasive grain 10.
[0027] The fine particles adhering to the inside of a drum 20 are ground with the scraping arm 24, and

non-adhered metal powder fixes in the shape of a dumpling on the front face of the plating abrasive grain 10 with a pressure plate 23 again. By repeating this activity fixed time, sequential sticking-by-pressure covering is carried out, the spherical shell-like sticking-by-pressure enveloping layer 11 is formed in the front face of the plating abrasive grain 10, and metal powder serves as the metallic-coating abrasive grain 12.

[0028] Next, the obtained metallic-coating abrasive grain 12 is sintered with a heating furnace, after carrying out compacting with well-known press equipment, or it carries out a hotpress with well-known hotpress equipment, and is fabricated in a desired grinding stone configuration (forming cycle). The process condition at this time should be experimentally set up suitably according to desired porosity.

[0029] Since oxygen oxidizes some of dissolution or/and metal powder to some metal powder in a sticking-by-pressure covering process according to the grinding stone manufacture approach which consists of the above-mentioned configuration, making metal powder stick by pressure on the plating abrasive grain 10 according to a mechanical friction welding operation, the sticking-by-pressure enveloping layer 11 with an oxygen content almost uniform to the interior can be formed. Since the whole region is covered and an oxygen content can form the almost uniform metallic-bond phase 4 by fabricating and sintering the metallic-coating abrasive grain 12 which has such a sticking-by-pressure enveloping layer 11, also when wearing the metallic-bond phase 4 out gradually by grinding, the wettability and reactivity of the metallic-bond phase 4 over **-ed material are always kept low, and the metal bonded grinding wheel which was stabilized [long duration] and which is burned and does the prevention effectiveness so can manufacture them easily.

[0030] In addition, in the grinding stone manufacture approach mentioned above, various fillers may be added to the metal powder for forming the sticking-by-pressure enveloping layer 11. In that case, it is possible to give the function according to a filler kind to the grinding stone after shaping. For example, since carbon powder will be gradually supplied to a grinding side when the obtained grinding stone is used for grinding if an about [5-20wt%] carbon particle is added in the metallic-bond phase 4 by mixing carbon powder to metal powder as a filler, improvement in sharpness by reduction of the grinding force by the lubrication disposition top and promotion of the cutting-edge operation from spontaneous generation of an abrasive grain can be aimed at.

[0031] If the hard particle of SiC or aluminum2O3 grade is similarly added to all the sticking-by-pressure all [a part or] 11, since a hard particle can be distributed in the metallic-bond phase 4 and it can arrange to homogeneity around each superabrasive 2, it is possible to give functions, such as to heighten the holding power of superabrasive 2, effectively.

[0032]

[Example(s) of Experiment] Next, the example of an experiment is given and the effectiveness of this invention is proved.

(Example 1 of an experiment) To the CBN abrasive grain of grain-size #200 / 230 (75/63 micrometer), Cu was galvanized by the nonelectrolytic plating method at the thickness of about 5 micrometers. This plating abrasive grain, Cu powder with a mean particle diameter of 5 micrometers, and Sn powder were fed into the equipment of drawing 4 , the drum 20 was rotated, and the sticking-by-pressure enveloping layer was formed. Sticking-by-pressure covering conditions were made into ambient atmosphere:air and processing-time:1 hour in path clearance:1.0mm of a pressure plate 23 and a drum 20, number of drum rotations:1200rpm, and a drum. The rate of the CBN volume in the obtained metallic-coating abrasive grain was 25vol(s)%. Moreover, the rate of Cu and Sn in a sticking-by-pressure enveloping layer was 85wt%Cu-15wt%Sn.

[0033] Next, after carrying out press forming of the metallic-coating abrasive grain, it sintered under 650-degree C nitrogen-gas-atmosphere mind for 30 minutes, and the cup mold grinding stone with 3mm [in the outer diameter of 200mm, the thickness of 20mm, width of face of 3mm of an abrasive grain layer grinding side, and thickness of an abrasive grain layer] and a bore of 75mm was produced. It was 1.2wt% when the oxygen content in the obtained metallic-bond phase was measured by oxygen, nitrogen, and the hydrogen analysis apparatus.

[0034] (Example 1 of a comparison) The back after it, on the other hand, prepared the same CBN

abrasive grain and the metal powder as the example 1 of an experiment so that it might become the same rate of the volume as the example 1 of an experiment, and mixing to homogeneity with a mixer completely produced the cup mold grinding stone of the same configuration on the same conditions. It was 0.3wt% when the oxygen content in the obtained metallic-bond phase was measured by oxygen, nitrogen, and the hydrogen analysis apparatus.
[0035] (Grinding trial) Using each cup mold grinding stone of the above-mentioned example 1 of an experiment, and the example 1 of a comparison, the grinding trial was performed on the following conditions and a grinding ratio and grinding force were measured, respectively.
used machine: -- arm-shaft-upright rotary grinder grinding stone peripheral-speed: -- 1300 m/min table delivery: -- 15rpm slitting: -- 30-micrometer grinding fluid: -- **-ed [soluble 50 dispensing-solution] material: -- SKD-11 (HRC45)
[0036] The result is shown in Table 1. In addition, the grinding ratio of front Naka is the value of the degree type in the time of processing **-ed material three times 300cm.
Grinding ratio =(amount of **-ed material grinding (cm3))/(the amount of grinding stone wear (cm3))
Moreover, grinding force is a value in the time of 300cm 3 processing.
[0037]
[Table 1]

	研削比	研削抵抗（ｋｇｆ）
実験例１	５４０	１２．５
比較例１	３０	２０．１

[0038] The grinding ratio of the example 1 of an experiment shows the example of a comparison 18 times [no less than] the value of one, and wear of a grinding stone was notably reduced so that clearly from Table 1. Moreover, grinding force has decreased to about 62%. This has little printing of the **-ed material to a grinding stone grinding side, and it depends it on abnormality wear of the abrasive grain layer resulting from the seizure of **-ed material and the rise of grinding force having been prevented. Moreover, the photograph which drawing 5 shows the grinding side after the grinding trial of the example 1 of an experiment, and drawing 6 are photographs in which the grinding side after the grinding trial of the example 1 of a comparison is shown. In the grinding stone of the example 1 of an experiment, adhesion of the **-ed material to a grinding side is hardly seen so that clearly from the comparison of these photographs.
[0039] (Example 2 of an experiment) To the diamond abrasive grain of grain-size #270 / 325 (53/45 micrometer), Cu was galvanized by the nonelectrolytic plating method at the thickness of about 3 micrometers. This plating abrasive grain, Cu powder with a mean particle diameter of 3 micrometers, and Sn powder with a mean particle diameter of 5 micrometers were fed into the equipment of drawing 4 , the drum 20 was rotated, and the sticking-by-pressure enveloping layer was formed. Sticking-by-pressure covering conditions were made into ambient atmosphere:air and processing-time:1 hour in path clearance:0.5mm of a pressure plate 23 and a drum 20, number of drum rotations:1500rpm, and a drum. The rate of the diamond volume in the obtained metallic-coating abrasive grain was 20vol(s)%. Moreover, the rate of Cu and Sn in a sticking-by-pressure enveloping layer was 80wt%Cu-20wt%Sn.
[0040] Next, after carrying out press forming of the metallic-coating abrasive grain, it sintered under 600-degree C nitrogen-gas-atmosphere mind for 30 minutes, and the straight-way-type grinding stone with 3mm [in 10mm in the outer diameter of 200mm and thickness and thickness of an abrasive grain layer] and a bore of 50.8mm was produced. It was 1.6wt% when the oxygen content in the obtained metallic-bond phase was measured by oxygen, nitrogen, and the hydrogen analysis apparatus.
[0041] (Example 2 of a comparison) The back after it, on the other hand, prepared the same diamond

abrasive grain and the metal powder as the example 2 of an experiment so that it might become the same rate of the volume as the example 2 of an experiment, and mixing to homogeneity with a mixer completely produced the straight-way-type grinding stone of the same configuration on the same conditions. It was 0.4 when the oxygen content in the obtained metallic-bond phase was measured by oxygen, nitrogen, and the hydrogen analysis apparatus.
[0042] (Grinding trial) Using each straight-way-type grinding stone of the above-mentioned example 2 of an experiment, and the example 2 of a comparison, the grinding trial was performed on the following conditions and a grinding ratio and grinding force were measured, respectively.
The machine used: Okamoto surface grinder "PSG52DXNC" (trade name)
wheel peripheral-speed: -- 1500 m/min table delivery: -- 10 m/min slitting: -- 150-micrometer cross feed-per-revolution: -- 5-micrometer grinding fluid: -- **-ed [soluble 50 dispensing-solution] material: -- a soda glass result is shown in Table 2. The grinding ratio and grinding force of front Naka are the same as the case of Table 1.
[0043]
[Table 2]

	研削比	研削抵抗（ｋｇｆ）
実験例２	２５００	１４．８
比較例２	１２００	１４．５

[0044] As shown in Table 2, the grinding ratio of the example 2 of an experiment is twice [about] the example 2 of a comparison, and wear of a grinding stone was reduced notably. Moreover, grinding force has also been reduced a little. Although fixing of the glass cutter powder to a grinding stone grinding side is intense, therefore it was easy to produce abnormality wear of an abrasive grain layer when **-ed material was glass, in the grinding stone of the example 2 of an experiment, chip eccritic improved, fixing of the glass cutter powder to a grinding stone grinding side was reduced, and abnormality wear of the abrasive grain layer resulting from it was able to be prevented.
[0045] (Example 3 of an experiment) To the diamond abrasive grain of grain-size #140 / 170 (106/90 micrometer), Cu was galvanized by the nonelectrolytic plating method at the thickness of about 10 micrometers. This plating abrasive grain, Cu powder with a mean particle diameter of 10 micrometers, and Sn powder were fed into the equipment of drawing 4 , the drum 20 was rotated, and the sticking-by-pressure enveloping layer was formed. Sticking-by-pressure covering conditions were made into ambient atmosphere:air and processing-time:1 hour in path clearance:0.5mm of a pressure plate 23 and a drum 20, number of drum rotations:1000rpm, and a drum. The rate of the diamond volume in the obtained metallic-coating abrasive grain was 25vol(s)%. Moreover, the rate of Cu and Sn in a sticking-by-pressure enveloping layer was 80wt%Cu-20wt%Sn.
[0046] Next, after carrying out press forming of the metallic-coating abrasive grain, it sintered under 600-degree C nitrogen-gas-atmosphere mind for 30 minutes, and the straight-way-type grinding stone with 3mm [in 10mm in the outer diameter of 200mm and thickness and thickness of an abrasive grain layer] and a bore of 50.8mm was produced. It was 0.8wt% when the oxygen content in the obtained metallic-bond phase was measured by oxygen, nitrogen, and the hydrogen analysis apparatus.
[0047] (Example 3 of a comparison) The back after it, on the other hand, prepared the same diamond abrasive grain and the metal powder as the example 3 of an experiment so that it might become the same rate of the volume as the example 3 of an experiment, and mixing to homogeneity with a mixer completely produced the straight-way-type grinding stone of the same configuration on the same conditions. It was 0.2wt% when the oxygen content in the obtained metallic-bond phase was measured by oxygen, nitrogen, and the hydrogen analysis apparatus.

[0048] (Grinding trial) Using each straight-way-type grinding stone of the above-mentioned example 3 of an experiment, and the example 3 of a comparison, the grinding trial was performed on the following conditions and change of the grinding force from grinding initiation was recorded. A result is shown in Table 3.
used machine: -- cylindrical-grinder wheel peripheral-speed: -- 1500 m/min table delivery: -- 10 m/min slitting: -- 50-micrometer grinding fluid: -- **-ed [soluble 50 dispensing-solution] material: -- number of **-ed [98% alumina] material rotations: -- 30rpm [0049]
[Table 3]

研削量 (cm^3)	研削抵抗 (kgf)	
	実験例3	比較例3
100	10.2	10.5
200	10.4	10.6
300	10.6	10.8
400	10.3	11.5
500	10.3	12.9
600	10.5	14.6
700	10.3	16.1
800	10.7	19.7
900	10.5	研削不能
1000	10.4	研削不能

[0050] As shown in Table 3, in the example 3 of a comparison, grinding force goes up gradually from immediately after grinding initiation, and grinding force hardly changed to the last in the example 3 of an experiment to having lapsed into grinding impossible soon.
[0051]
[Effect of the Invention] Since the metallic-bond phase is formed with the sintered alloy containing Cu which is 20 - 95wt%, Sn which is 5 - 50wt%, and the oxygen which is 0.5 - 3wt% according to the metal bonded grinding wheel concerning this invention as explained above, the wettability and reactivity over **-ed material of a metallic-bond phase are low. Thereby, **-ed material can be burned into grinding in a grinding stone grinding side, or it can prevent fixing.
[0052] Moreover, since mixed powder is made to contain oxygen in a sticking-by-pressure covering process according to the manufacture approach of the metal bonded grinding wheel concerning this invention, making the mixed powder of each metal stick by pressure on a plating abrasive grain according to a mechanical friction welding operation, a sticking-by-pressure enveloping layer with an

oxygen content almost uniform to the interior can be formed. Since the whole region is covered and an oxygen content can form an almost uniform metallic-bond phase by fabricating and sintering the metallic-coating abrasive grain which has such a sticking-by-pressure enveloping layer, also when wearing the metallic-bond phase out gradually by grinding, the wettability and reactivity of a metallic-bond phase over **-ed material are always kept low, and the printing prevention effectiveness stabilized [long duration] is acquired.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross-section enlarged drawing showing one example of the metal bonded grinding wheel concerning this invention.
[Drawing 2] It is the cross-section enlarged drawing showing other examples of this invention.
[Drawing 3] It is the explanatory view of one example of the manufacture approach of the metal bonded grinding wheel concerning this invention.
[Drawing 4] It is the schematic diagram showing the pressurization rolling equipment used at the sticking-by-pressure covering process of this example.
[Drawing 5] It is the enlargement of the grinding side after the grinding trial of the metal bonded grinding wheel of the example 1 of an experiment.
[Drawing 6] It is the enlargement of the grinding side after the grinding trial of the metal bonded grinding wheel of the example 1 of a comparison.
[Description of Notations]
1 Metal-Bond Abrasive Grain Layer
2 Superabrasive
3 Metal Plating Layer
4 Metallic-Bond Phase
4A Spherical shell-like part
5 Interface
6 Independent Pore
10 Plating Abrasive Grain
11 Sticking-by-Pressure Enveloping Layer
12 Metallic-Coating Abrasive Grain
20 Drum
23 Pressure Plate
24 Scraping Arm

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平7－246562

(43)公開日　平成7年(1995)9月26日

(51)Int.Cl.⁶		識別記号	庁内整理番号	F I	技術表示箇所
Ｂ２４Ｄ	3/06	Ａ			
	3/00	３３０　Ｄ			
		３４０			
	3/10				

審査請求　未請求　請求項の数６　ＦＤ　（全 ９ 頁）

(21)出願番号　特願平6－65752

(22)出願日　平成6年(1994)3月9日

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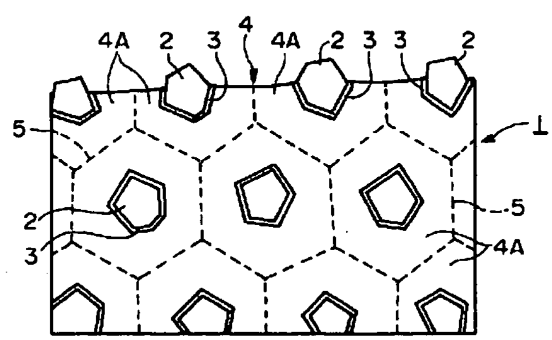
(54)【発明の名称】　メタルボンド砥石およびその製造方法

(57)【要約】

【目的】　研削面への被削材の焼き付きが防止できるメタルボンド砥石、およびその製造方法を提供する。

【構成】　金属結合相４中に超砥粒２を分散したメタルボンド砥粒層１を具備する。金属結合相４は、２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金で形成されている。超砥粒２は金属結合相４中でほぼ均等な間隔を空けて３次元的に分散配置され、金属結合相４は、個々の超砥粒２の外周を球殻状に包囲する球殻状部分４Ａを有し、これら球殻状部分４Ａが互いの境界面５で連続して金属結合相４が構成されている。



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【特許請求の範囲】

【請求項１】金属結合相中に超砥粒を分散してなるメタルボンド砥粒層を備えたメタルボンド砥石であって、
前記金属結合相は、２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金で形成されていることを特徴とするメタルボンド砥石。

【請求項２】前記金属結合相は、さらにＦｅ，Ｎｉ，Ｃｏ，Ｗ，Ｔｉ，Ａｇから選択される１種または2種以上の金属を含有することを特徴とする請求項１記載のメタルボンド砥石。

【請求項３】前記超砥粒は前記金属結合相中で互いにほぼ均等な間隔を空けて３次元的に分散配置されるとともに、前記金属結合相は、個々の超砥粒の外周をそれぞれ球殻状に包囲するほぼ一定径の球殻状部分を有し、隣接しあう球殻状部分が互いの接触面で連続して前記金属結合相が構成されていることを特徴とする請求項１または２記載のメタルボンド砥石。

【請求項４】前記球殻状部分相互の境界には独立気孔が形成され、これにより前記メタルボンド砥粒層の気孔率が5～３０ｖｏｌ％とされていることを特徴とする請求項3記載のメタルボンド砥石。

【請求項５】前記球殻状部分の平均外径は、前記超砥粒の平均粒径の１．２～４倍とされていることを特徴とする請求項3または4記載のメタルボンド砥石。

【請求項6】超砥粒の表面に無電解めっき法により金属めっき層を形成してめっき砥粒を作製するめっき工程と、
前記めっき砥粒を、これらめっき砥粒よりいずれも平均粒径が小さいＣｕ粉末およびＳｎ粉末を主原料とする混合粉末と混合し、酸素存在下において加圧転動運動を加え、機械的な摩擦圧接作用によって前記金属めっき層上に前記各金属の混合粉末を圧着させることにより、前記めっき砥粒の外周に圧着被覆層を形成して金属被覆砥粒を作製し、しかもその過程で前記混合粉末に酸素を含有させる圧着被覆工程と、
前記金属被覆砥粒を圧粉成形および焼結、あるいはホットプレスすることにより前記圧着被覆層を結合させ、２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～3ｗｔ％の酸素を含有する焼結合金とし、これによりメタルボンド砥粒層を形成する成形工程とを具備することを特徴とするメタルボンド砥石の製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、研削面への被削材の焼き付きや固着が防止できるメタルボンド砥石およびその製造方法に関するものである。

【０００２】

【従来の技術】一般的なメタルボンド砥石は、Ｃｕまたは Ｓｎなどの金属粉末に、ダイヤモンドまたはＣＢＮ等の超砥粒を均一に混合し、この混合粉末を台金とともに型込めした後、これらをプレス成形および焼結して製造されている。なお、結合相となる焼結金属中の酸素含有量は、一般に、焼結性を高める観点から少ない方がよいとされている。

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【０００３】

【発明が解決しようとする課題】ところが、従来のメタルボンド砥石においては、比較的柔らかい金属やガラスなどの被削材を研削する場合、被削材が砥石の研削面に層状に焼き付きまたは固着しやすく、短時間で切れ味が低下して研削抵抗が増し、研削不能に至り、寿命が短いという欠点があった。

【０００４】本発明は上記事情に鑑みてなされたもので、研削面への被削材の焼き付きや固着が防止できるメタルボンド砥石、およびその製造方法を提供することを課題としている。

【０００５】

【課題を解決するための手段】前記課題を解決するため、本発明に係るメタルボンド砥石は、金属結合相中に超砥粒を分散してなるメタルボンド砥粒層を備えたメタルボンド砥石であって、前記金属結合相は、２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金で形成されていることを特徴とする。

【０００６】なお、金属結合相は、さらにＦｅ，Ｎｉ，Ｃｏ，Ｗ，Ｔｉ，Ａｇから選択される１種または2種以上の金属を含有してもよい。また、超砥粒は前記金属結合相中で互いにほぼ均等な間隔を空けて３次元的に分散配置されるとともに、前記金属結合相は、個々の超砥粒の外周をそれぞれ球殻状に包囲するほぼ一定径の球殻状部分を有し、隣接しあう球殻状部分が互いの接触面で連続して前記金属結合相が構成されていてもよい。

【０００７】一方、本発明に係るメタルボンド砥石の製造方法は、超砥粒の表面に無電解めっき法により金属めっき層を形成してめっき砥粒を作製するめっき工程と、前記めっき砥粒を、これらめっき砥粒よりいずれも平均粒径が小さいＣｕ粉末およびＳｎ粉末を主原料とする混合粉末と混合し、酸素存在下において加圧転動運動を加え、機械的な摩擦圧接作用によって前記金属めっき層上に前記各金属の混合粉末を圧着させることにより、前記めっき砥粒の外周に圧着被覆層を形成して金属被覆砥粒を作製し、しかもその過程で前記混合粉末に酸素を含有させる圧着被覆工程と、前記金属被覆砥粒を圧粉成形および焼結、あるいはホットプレスすることにより前記圧着被覆層を結合させ、２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金とし、これによりメタルボンド砥粒層を形成する成形工程とを具備することを特徴とする。

【０００８】

【作用】本発明に係るメタルボンド砥石によれば、金属

結合相が２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金で形成されているため、金属結合相の被削材に対する濡れ性および反応性が低い。これにより、研削中に被削材が砥石研削面に焼き付くことが少ない。

【０００９】また、本発明に係るメタルボンド砥石の製造方法によれば、圧着被覆工程において、機械的な摩擦圧接作用によりめっき砥粒上に各金属の混合粉末を圧着させながら、前記混合粉末に酸素を含有させるので、酸素含有量が内部までほぼ均一な圧着被覆層を形成することができる。このような圧着被覆層を有する金属被覆砥粒を成形・焼結することにより、全域に亙って酸素含有量がほぼ一様な金属結合相が形成できるから、研削により金属結合相が漸次磨耗していく場合にも、被削材に対する金属結合相の濡れ性および反応性は常に低く保たれ、長時間に亙って安定した焼き付きや固着防止効果が得られる。

【００１０】

【実施例】次に、本発明に係るメタルボンド砥石およびその製造方法の実施例を詳細に説明する。図１は第１実施例のメタルボンド砥石のメタルボンド砥粒層１を示す断面拡大図である。本発明はこのメタルボンド砥粒層１の構造に特徴を有するものであるから、砥粒層１のみにより砥石が構成されていてもよいし、適当な砥石基体に砥粒層１が固定されていてもよい。本発明では砥石の形状も限定されず、従来使用されているいかなる形式および形状の砥石にも適用可能である。

【００１１】メタルボンド砥粒層１は、ダイヤモンドまたはＣＢＮ等の超砥粒２を、金属結合相４中において、互いにほぼ均等な間隔を空けて３次元的に分散配置してなるもので、金属結合相4は、個々の超砥粒２の外周をそれぞれ球殻状に包囲するほぼ一定径の球殻状部分４Ａを有し、これら球殻状部分４Ａが互いの接触面で連続することにより金属結合相４が構成されている。また、球殻状部分４Ａは、超砥粒２の外周に直接形成された薄い金属めっき層３と、その外周に設けられた焼結合金層とにより構成されている。ただし、金属めっき層３とその外周の焼結合金層とは明瞭な境界を有するものではなく、実際には相互に拡散しあうことにより境界が不明瞭になっていてもよい。球殻状部分４Ａの境界面５も同様である。

【００１２】金属結合相4は、Ｃｕを２０～９５ｗｔ％、より好ましくは３５～７０ｗｔ％、Ｓｎを５～５０ｗｔ％、より好ましくは１０～３０ｗｔ％、および酸素を０．５～3ｗｔ％、より好ましくは1～2ｗｔ％それぞれ含有している。これら元素以外に、Ｆｅ，Ｎｉ，Ｃｏ，W，Ｔｉ，Ａｇから選択される１種または2種以上の金属を望ましくは5０ｗｔ％以下含有してもよいし、その他少量の不可避不純物や、必要に応じては添加元素またはフィラーを含んでいてもよい。なお、金属めっき層３の金属結合相４中に占める割合は小さいので、金属結合相４の組成は焼結合金層の組成と考えてよい。

【００１３】金属めっき層3は、焼結金属層と超砥粒２との接合性を高めるために形成されたもので、無電解めっき法（場合によってはさらに電解めっきを行ってもよい）により超砥粒２の外周面に形成されている。金属めっき層3の材質としてはＣｕ，Ｎｉ，Ｃｏ，Ａｇ等、特に好適にはＣｕが選択され、その厚さは製造上の理由から２～２０μｍ程度とされている。

【００１４】金属結合相４中のＳｎ含有量が５ｗｔ％より少ないと焼結性が不足する問題を生じ、５０ｗｔ％を越えると金属結合相４が脆弱化して砥石として使用できなくなる。一方、金属結合相４中のＣｕの含有量が２０ｗｔ％より少ないと脆弱化して砥石を成形できない問題を生じ、９５ｗｔ％を越えると焼結が困難になるという問題を生じる。

【００１５】金属結合相４中における酸素原子の存在形態は明らかではないが、Ｃｕ，Ｓｎ等の酸素固溶金属相または金属酸化物として存在するものと考えられ、酸素原子の分布は、焼結合金層の全域に亙ってほぼ均一であることが望ましい。金属結合相４中の酸素含有量が０．５ｗｔ％未満であると、焼き付きや固着の防止効果が得られず、３ｗｔ％より多いと金属結合相４の強度が不足して十分な砥粒保持力が得られない。

【００１６】球殻状部分４Ａの平均外径、すなわち超砥粒２の離間ピッチは、超砥粒２の平均粒径の１．２～４倍、より好ましくは１．５～2倍とされており、これにより超砥粒２の集中度は、５０～２５０程度に設定されていることが望ましい。超砥粒２の集中度が５０未満であると切刃密度が不足して切れ味が低下し、２５０より大の砥石は金属結合相４による砥粒保持力が不足して製造困難である。

【００１７】上記構成からなるメタルボンド砥石によれば、金属結合相4が２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金で形成されているため、被削材に対する金属結合相４の濡れ性および反応性が低い。これにより、研削中に被削材が砥石研削面に焼き付くことが防止でき、切れ味の早期低下を防ぐことが可能で、砥石寿命の延長が図れる。しかも、金属結合相４の全域に亙って上記組成が保たれているので、金属結合相４が漸次磨耗していっても焼き付き防止作用が変化せず、長期に亙って安定した効果が得られる。

【００１８】また、個々の超砥粒２の間隔が球殻状部分４Ａの厚さで規定されているため、研削面における超砥粒２の分布が従来の砥石に比して均一で、切れ味のばらつきが少ないうえ、研削精度のばらつきも低減できる。

【００１９】なお、図１の例ではメタルボンド砥粒層１がほぼ無気孔であったが、その代わりに、図２に示すように、球殻状部分４Ａの境界面５に沿って独立気孔６が

形成されていてもよい。このような独立気孔6の大きさや存在量は、メタルボンド砥粒層1を成形する際の条件によりある程度調整可能である。メタルボンド砥粒層1内に独立気孔6を形成する場合、その気孔率は5～30ｖｏｌ％であることが望ましい。この範囲であれば、金属結合相4の強度をほとんど低下することなく、研削面からの切粉排出性や、研削液による砥石の冷却性を高めることができ、結果的に切れ味をいっそう向上することが可能である。

【００２０】次に、上記メタルボンド砥石の製造方法の実施例を図3および図4を用いて説明する。この方法ではまず、図3（ａ）に示すような超砥粒２を用意し、無電解めっき法によりその外周面に金属めっき層3を形成し、図3（ｂ）に示すようなめっき砥粒１０を作製する。金属めっき層３の好適な厚さは先に述べたように製造上の理由から２～２０μｍ程度である。２μｍ未満では圧着被覆層１１の形成が困難になり、２０μｍより厚いとコスト的に無駄が生じることによる。

【００２１】金属めっき層3は無電解めっき法のみによって形成することも可能であるが、必要に応じては、無電解めっき後にさらに電解めっきを施して金属めっき層３を厚肉化してもよい。なお、超砥粒２の形状は、後述する加圧撹拌中のめっき砥粒１０の転がり性を向上し、圧着被覆層１１の均一形成を容易にするため、球状に近い方が好ましいが、極端な鱗片状でない限り、不定形の砥粒を用いても圧着被覆層１１は十分形成可能である。

【００２２】次に、めっき砥粒１０の外周に厚い圧着被覆層１１を形成して、図3（ｃ）に示すような金属被覆砥粒１２を作製する（圧着被覆工程）。具体的には、めっき砥粒１０と、これらめっき砥粒１０よりいずれも平均粒径が小さいＣｕ粉末、Ｓｎ粉末、並びに必要に応じてＦｅ，Ｎｉ，Ｃｏ，Ｗ，Ｔｉ，Ａｇから選択される１種または２種以上の金属粉末とを混合し、この混合物に酸素存在下で加圧転動運動を加え、機械的な摩擦圧接作用によって金属めっき層３上に金属粉末を圧着させる。同時に、その過程で金属粉末の一部の固溶酸素量を増大させ、または／および金属粉末の一部を酸化させ、圧着被覆層１１内に酸素固溶金属相または／および金属酸化物を生成させる。酸素存在雰囲気としては空気中でよいが、他の酸化性ガスを適度に不活性ガスで希釈して使用してもよい。

【００２３】図4は上記圧着被覆工程で使用する加圧転動装置の一例を示す。図中符号２０は軸線を水平にして設置された円筒状のドラムであり、軸線を中心として駆動機により回転される。ドラム２０の内部には、軸線に沿って固定シャフト２１が配置され、このシャフト２１には下向きに加圧アーム２２が固定され、その下端には、ドラム２０の内面と平行な円弧状をなす加圧板２３が固定され、この加圧板２３とドラム２０内面との間には、一定の間隙が形成されている。また、加圧アーム２２よりドラム回転方向後方側には、斜め下方に延びる掻き取りアーム２４が固定され、その下端は刃先状に形成され、ドラム２０内面に付着した粉体を掻き落とす作用を果たす。

【００２４】圧着被覆を行なうには、めっき砥粒１０と前記金属粉末とを所定の割合でドラム２０に入れ、その開口部を蓋（図示略）で塞ぐことにより、ドラム２０を密閉する。なお、使用する金属粉末の平均粒径は０．１～５０μｍであることが望ましい。０．１μｍ未満では圧着被覆と同時に金属粉末同士の凝集が起こり易くなり、圧着被覆層の形成が困難になる。逆に、５０μｍより大では、めっき砥粒１０が中心核になりにくく、金属粉末同士の圧着凝集が起こり好ましくない。

【００２５】ドラム２０内に投入するめっき砥粒１０と金属粉末との混合比は、形成すべき圧着被覆層３の厚さに応じて決定されるが、効率良く圧着被覆層を形成するには体積比で、

めっき砥粒量：金属粉末量＝１０：１～１：５

程度が好ましい。１回の圧接被覆では被覆厚さが足りない場合には、途中で金属粉末を追加して圧着被覆を続行すればよい。

【００２６】混合粉末をドラム２０に投入した状態でドラム２０を回転させると、混合粉体が加圧板２３とドラム２０の隙間で加圧され、粒子同士の衝突および摩擦によって各粒子の界面に局所的な発熱および衝撃力、延性力が生じ、めっき砥粒１０の表面に金属粉末が団子状に固着する。

【００２７】ドラム２０の内面に付着した粉体は掻き取りアーム２４で粉砕され、未付着の金属粉末は再び加圧板２３でめっき砥粒１０の表面に団子状に固着される。この作業を一定時間繰り返すことにより、金属粉末はめっき砥粒１０の表面に順次圧着被覆され、球殻状の圧着被覆層１１が形成され、金属被覆砥粒１２となる。

【００２８】次に、得られた金属被覆砥粒１２を、周知のプレス装置により圧粉成形したうえで加熱炉により焼結するか、あるいは周知のホットプレス装置によりホットプレスし、所望の砥石形状に成形する（成形工程）。この時の成形条件は、所望の気孔率に応じて実験的に適宜設定すべきである。

【００２９】上記構成からなる砥石製造方法によれば、圧着被覆工程において、機械的な摩擦圧接作用によりめっき砥粒１０上に金属粉末を圧着させながら、金属粉末の一部に酸素を固溶または／および金属粉末の一部を酸化させるので、酸素含有量が内部までほぼ均一な圧着被覆層１１を形成することができる。このような圧着被覆層１１を有する金属被覆砥粒１２を成形・焼結することにより、全域に亙って酸素含有量がほぼ一様な金属結合相４が形成できるから、研削により金属結合相４が漸次磨耗していく場合にも、被削材に対する金属結合相４の濡れ性および反応性は常に低く保たれ、長時間に亙って

安定した焼き付き防止効果を奏するメタルボンド砥石が容易に製造できる。

【0030】なお、上述した砥石製造方法において、圧着被覆層11を形成するための金属粉末に各種フィラーを添加しても良い。その場合には、成形後の砥石に、フィラー種に応じた機能を付与することが可能である。例えば、フィラーとしてカーボン粉を金属粉末に混合しておくことにより、金属結合相4中に5～20wt％程度のカーボン粒子を添加すれば、得られた砥石を研削に使用した際に研削面に徐々にカーボン粉が供給されるため、潤滑性向上による研削抵抗の削減および砥粒の自生発刃作用の促進による切れ味向上を図ることができる。

【0031】同様に圧着被覆層11の一部または全てにSiCやAl_2O_3等の硬質粒子を添加しておけば、金属結合相4中に硬質粒子を分散させ、個々の超砥粒2の周囲に均一に配置することができるから、超砥粒2の保持力を高めるなどの機能を効果的に付与することが可能である。

【0032】

【実験例】次に、実験例を挙げて本発明の効果を実証する。

（実験例1）粒度＃200／230（75／63μm）のCBN砥粒に、無電解めっき法によりCuを約5μmの厚さにめっきした。このめっき砥粒と、平均粒径5μmのCu粉末およびSn粉末を、図4の装置に投入し、ドラム20を回転させて圧着被覆層を形成した。圧着被覆条件は、加圧板23とドラム20とのクリアランス：1．0mm、ドラム回転数：1200rpm、ドラム内雰囲気：空気、処理時間：1時間とした。得られた金属被覆砥粒中のCBN体積率は25vol％だった。また圧着被覆層中のCuとSnの割合は、85wt％Cu－＊15wt％Snであった。

【0033】次に、金属被覆砥粒をプレス成形したうえ、650℃の窒素雰囲気下で30分焼結し、外径200mm、厚さ20mm、砥粒層研削面の幅3mm、砥粒層の厚さ3mm、内径75mmのカップ型砥石を作製した。得られた金属結合相中の酸素含有率を酸素・窒素・水素分析装置で測定したところ1．2wt％であった。

【0034】（比較例1）一方、実験例1と同じCBN砥粒および金属粉末を、実験例1と同じ体積率になるように調合し、混合機で均一に混合したうえ、後は全く同一の条件で同一形状のカップ型砥石を作製した。得られた金属結合相中の酸素含有率を酸素・窒素・水素分析装置で測定したところ、0．3wt％であった。

【0035】（研削試験）上記実験例1および比較例1の各カップ型砥石を用いて、下記条件で研削試験を行ない、研削比と研削抵抗をそれぞれ測定した。

使用機械：立軸ロータリー研削盤

砥石周速：1300m／min

テーブル送り：15rpm

切り込み：30μm

研削液：ソリュブル50倍液

被削材：SKD－11（HRC45）

【0036】その結果を表1に示す。なお表中の研削比は、被削材を300cm³加工した時点での次式の値である。

研削比＝（被削材研削量（cm^3））／（砥石磨耗量（cm^3））

また、研削抵抗は、300cm³加工の時点での値である。

【0037】

【表1】

	研削比	研削抵抗（kgf）
実験例1	540	12．5
比較例1	30	20．1

【0038】表1から明らかなように、実験例1の研削比は比較例1の18倍もの値を示しており、砥石の磨耗が顕著に低減された。また、研削抵抗が62％程度にまで低減できた。これは、砥石研削面への被削材の焼き付きが少なく、被削材の焼き付きに起因する砥粒層の異常磨耗や研削抵抗の上昇が防止できたことによる。また、図5は実験例1の研削試験後の研削面を示す写真、図6は比較例1の研削試験後の研削面を示す写真である。これらの写真の比較から明らかなように、実験例1の砥石では研削面への被削材の付着が殆ど見られない。

【0039】（実験例2）粒度＃270／325（53／45μm）のダイヤモンド砥粒に、無電解めっき法に※よりCuを約3μmの厚さにめっきした。このめっき砥粒と、平均粒径3μmのCu粉末および平均粒径5μmのSn粉末を、図4の装置に投入し、ドラム20を回転させて圧着被覆層を形成した。圧着被覆条件は、加圧板23とドラム20とのクリアランス：0．5mm、ドラム回転数：1500rpm、ドラム内雰囲気：空気、処理時間：1時間とした。得られた金属被覆砥粒中のダイヤモンド体積率は20vol％だった。また圧着被覆層中のCuとSnの割合は、80wt％Cu－20wt％Snであった。

【0040】次に、金属被覆砥粒をプレス成形したうえ、600℃の窒素雰囲気下で30分焼結し、外径20

0mm、厚さ10mm、砥粒層の厚さ3mm、内径50．8mmのストレート型砥石を作製した。得られた金属結合相中の酸素含有率を酸素・窒素・水素分析装置で測定したところ、1．6wt％であった。

【0041】（比較例2）一方、実験例2と同じダイヤモンド砥粒および金属粉末を、実験例2と同じ体積率になるように調合し、混合機で均一に混合したうえ、後は全く同一の条件で同一形状のストレート型砥石を作製した。得られた金属結合相中の酸素含有率を酸素・窒素・水素分析装置で測定したところ、0．4であった。

【0042】（研削試験）上記実験例2および比較例2の各ストレート型砥石を用いて、下記条件で研削試験を行ない、研削比と研削抵抗をそれぞれ測定した。

使用機械：岡本平面研削盤「PSG52DXNC」（商品名）
ホイール周速：1500m／min
テーブル送り：10m／min
切り込み：150μm
クロス送り量：5μm
研削液：ソリュブル50倍液
被削材：ソーダガラス

結果を表2に示す。表中の研削比および研削抵抗は表1の場合と同じである。

【0043】

【表2】

	研削比	研削抵抗（kgf）
実験例2	2500	14．3
比較例2	1200	14．5

【0044】表2に示すように、実験例2の研削比は比較例2の約2倍であり、砥石の磨耗が顕著に低減された。また、研削抵抗も若干低減できた。被削材がガラスの場合には砥石研削面へのガラス切粉の固着が激しく、そのために砥粒層の異常磨耗が生じやすいが、実験例2の砥石では切粉排出性が向上され、砥石研削面へのガラス切粉の固着が低減され、それに起因する砥粒層の異常磨耗を防止することができた。

【0045】（実験例3）粒度＃140／170（106／90μm）のダイヤモンド砥粒に、無電解めっき法によりCuを約10μmの厚さにめっきした。このめっき砥粒と、平均粒径10μmのCu粉末およびSn粉末を、図4の装置に投入し、ドラム20を回転させて圧着被覆層を形成した。圧着被覆条件は、加圧板23とドラム20とのクリアランス：0．5mm、ドラム回転数：1000rpm、ドラム内雰囲気：空気、処理時間：1時間とした。得られた金属被覆砥粒中のダイヤモンド体積率は25vol％だった。また圧着被覆層中のCuとSnの割合は、80wt％Cu－20wt％Snであった。

【0046】次に、金属被覆砥粒をプレス成形したうえ、600℃の窒素雰囲気下で30分焼結し、外径200mm、厚さ10mm、砥粒層の厚さ3mm、内径50．8mmのストレート型砥石を作製した。得られた金属結合相中の酸素含有率を酸素・窒素・水素分析装置で測定したところ、0．8wt％であった。

【0047】（比較例3）一方、実験例3と同じダイヤモンド砥粒および金属粉末を、実験例3と同じ体積率になるように調合し、混合機で均一に混合したうえ、後は全く同一の条件で同一形状のストレート型砥石を作製した。得られた金属結合相中の酸素含有率を酸素・窒素・水素分析装置で測定したところ、0．2wt％であった。

【0048】（研削試験）上記実験例3および比較例3の各ストレート型砥石を用いて、下記条件で研削試験を行ない、研削開始からの研削抵抗の変化を記録した。結果を表3に示す。

使用機械：円筒研削盤
ホイール周速：1500m／min
テーブル送り：10m／min
切り込み：50μm
研削液：ソリュブル50倍液
被削材：98％アルミナ
被削材回転数：30rpm

【0049】

【表3】

研削量（ｃｍ^3）	研削抵抗（ｋｇｆ）	
	実験例３	比較例３
１００	１０．２	１０．５
２００	１０．４	１０．６
３００	１０．６	１０．８
４００	１０．３	１１．５
５００	１０．３	１２．９
６００	１０．５	１４．６
７００	１０．３	１６．１
８００	１０．７	１９．７
９００	１０．５	研削不能
１０００	１０．４	研削不能

【００５０】表３に示すように、比較例３では研削開始直後から漸次研削抵抗が上昇していき、やがて研削不能に陥ったのに対し、実験例３では最後まで研削抵抗が殆ど変化しなかった。

【００５１】

【発明の効果】以上説明したように、本発明に係るメタルボンド砥石によれば、金属結合相が２０～９５ｗｔ％のＣｕ、５～５０ｗｔ％のＳｎ、および０．５～３ｗｔ％の酸素を含有する焼結合金で形成されているため、金属結合相の被削材に対する濡れ性および反応性が低い。これにより、研削中に被削材が砥石研削面に焼き付いたり固着することが防止できる。

【００５２】また、本発明に係るメタルボンド砥石の製造方法によれば、圧着被覆工程において、機械的な摩擦圧接作用によりめっき砥粒上に各金属の混合粉末を圧着させながら混合粉末に酸素を含有させるので、酸素含有量が内部までほぼ均一な圧着被覆層を形成することができる。このような圧着被覆層を有する金属被覆砥粒を成形・焼結することにより、全域に亘って酸素含有量がほぼ一様な金属結合相が形成できるから、研削により金属結合相が漸次磨耗していく場合にも、被削材に対する金属結合相の濡れ性および反応性は常に低く保たれ、長時間に亘って安定した焼き付き防止効果が得られる。

【図面の簡単な説明】

【図１】本発明に係るメタルボンド砥石の一実施例を示す断面拡大図である。

【図２】本発明の他の実施例を示す断面拡大図である。

【図３】本発明に係るメタルボンド砥石の製造方法の一実施例の説明図である。

【図４】同実施例の圧着被覆工程で使用する加圧転動装置を示す概略図である。

【図５】実験例１のメタルボンド砥石の研削試験後の研削面の拡大写真である。

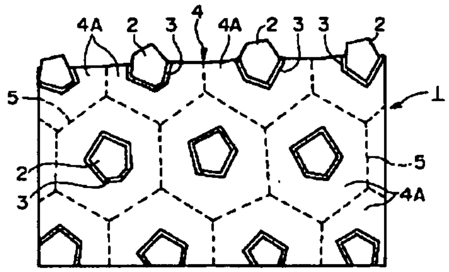
【図６】比較例１のメタルボンド砥石の研削試験後の研削面の拡大写真である。

【符号の説明】

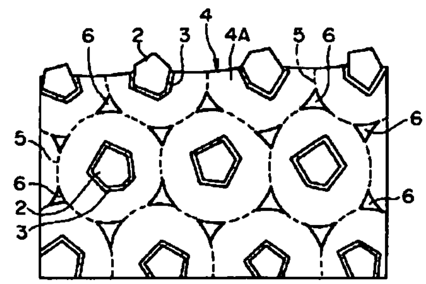
１　メタルボンド砥粒層
２　超砥粒
３　金属めっき層
４　金属結合相
４Ａ　球殻状部分
５　境界面
６　独立気孔
１０　めっき砥粒
１１　圧着被覆層
１２　金属被覆砥粒

20　ドラム
23　加圧板
24　掻き取りアーム

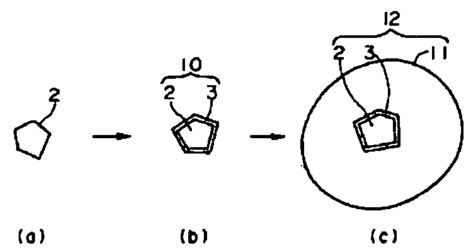
【図1】



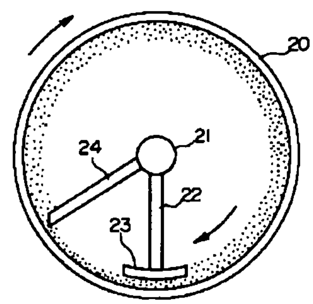
【図2】



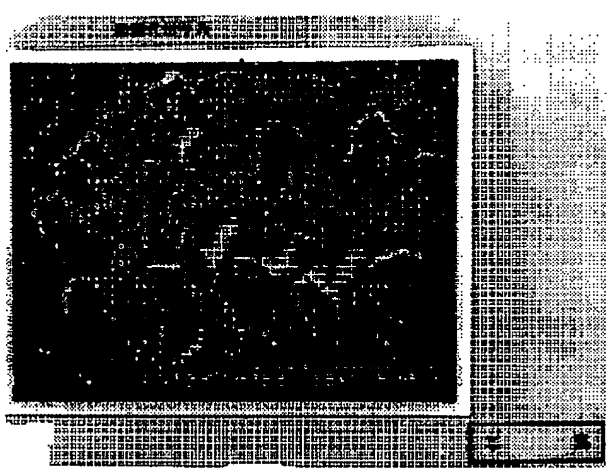
【図3】



【図4】



【図5】



【図6】